Preliminary Study of Layer-dependent Corrections

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Overview and MC Samples

- Great improvement of energy resolution when using the Cerenkov info
  - $f_{em} \longleftrightarrow \frac{E_{cerpho}}{E_{ion}}$
  - E_{ion} and E_{cerpho} were obtained by summing up the ionization energy from all active layers and energy of Cerenkov photons from all Cerenkov layers, respectively.
  - Improvements have been seen in both cases: single particle and jet.
- Can we gain further improvements by using f_{em} from each layer?
  - On April 3rd, we showed that there's a ~6% improvement with respect to the layer-independent correction by dividing data into 12 f_{em} bins.
  - Can we make it better than 6%?
  - Will focus on the configuration: 3 mm active layer, 2 mm Cerenkov layer and 0 mm absorber layer.
  - Will focus on the 10 GeV electrons and pions
- MC samples
  - e-_E10.0_N10000_Tac0._Tch1.0_Tab0.0_MactLeadGlass_MabsLeadGlass.root
  - pi-_E10.0_N10000_Tac0._Tch1.0_Tab0.0_MactLeadGlass_MabsLeadGlass.root

Previous Strategy

- We wish to minimize: $\sum_i^{N_{ev}} \left\{ E_{input} - \sum_j^{N_{layer}} E_{ion}^j \beta(f_{em}^j) \right\}^2$

- Layers with similar f_{em} should have similar energy corrections. So we assume the correction formula $\beta(f_{em})$ only depends on f_{em}, not the physical location (or layer index).

- To guess the functional form of β, we binned the f_{em}^j into 12 bins and fit the following 12 free parameters $\mathcal{G}_k$ by minimizing the following term in MINUIT

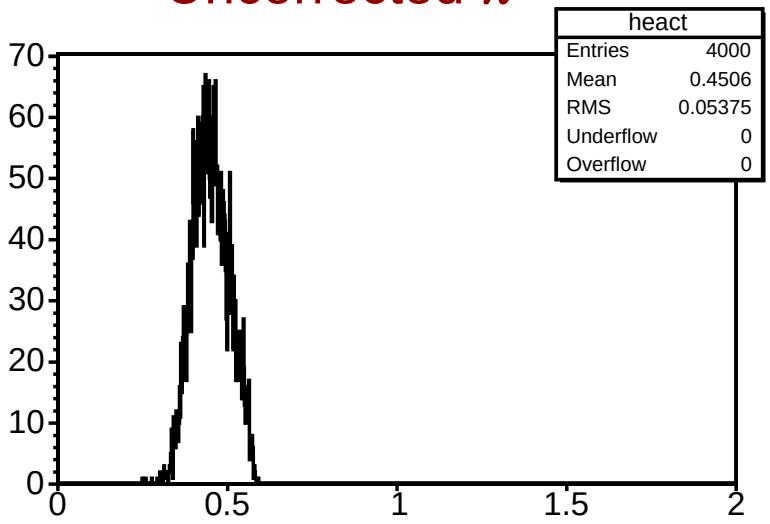
$$\sum_i^{N_{ev}} \left\{ E_{input} - \sum_k^{N_{bin}} E_{ion}^k \mathcal{G}_k \right\}^2$$

  - E_{ion}^k is the sum of ionization energy for layers with f_{em} in the same bin
  - 12 bins are determined by giving similar number of events in each bin

Summary from Last Presentation

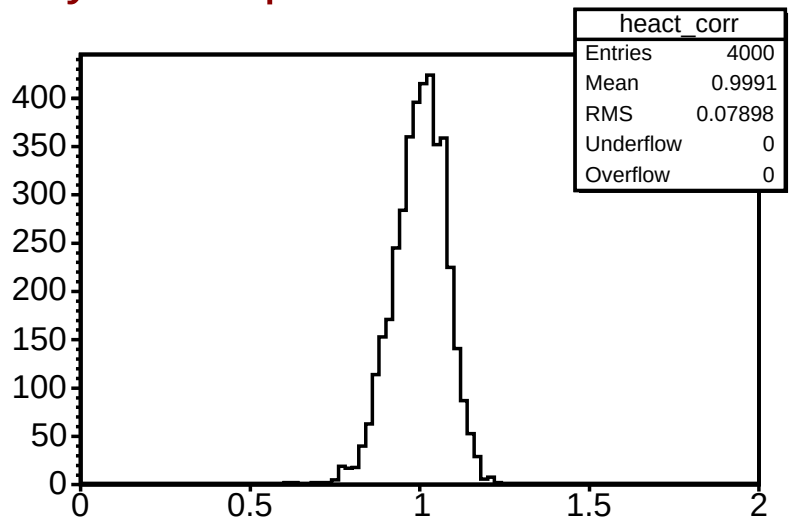
10 GeV Electron and Pion Energy Response

Uncorrected π



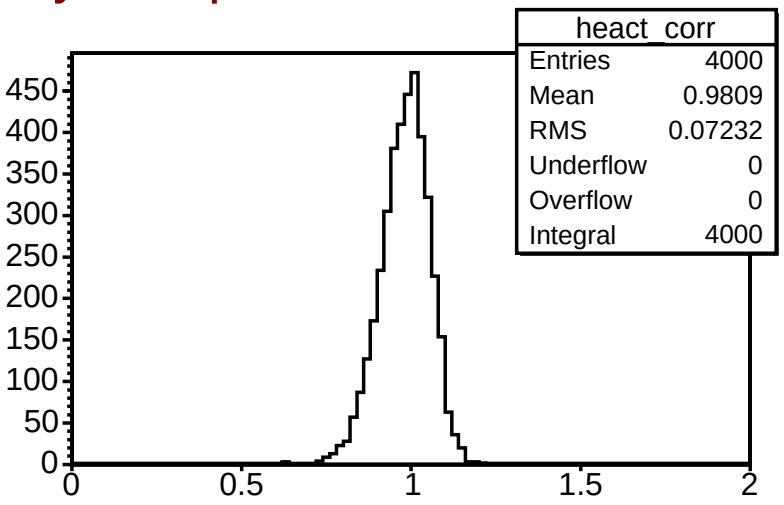
Uncorrected response of pions

Layer-independent correction



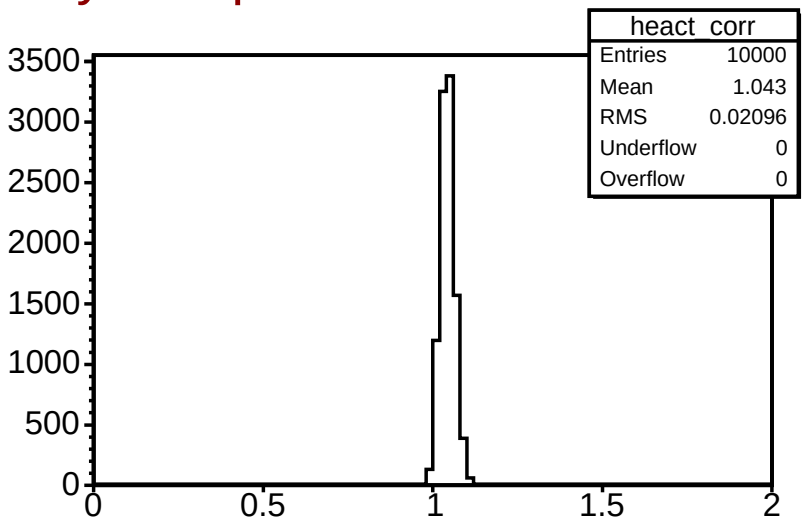
Corrected response of pions

Layer-dependent correction π



Corrected response of pions

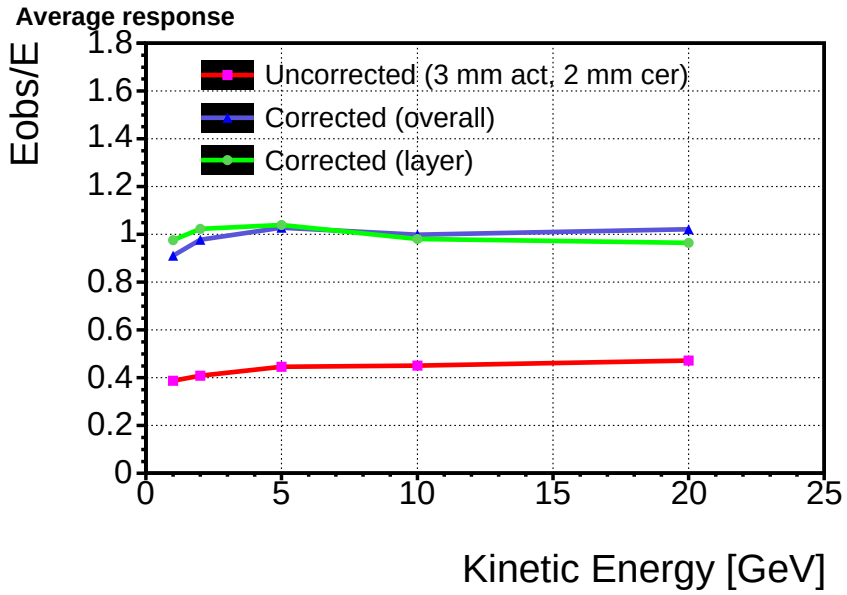
Layer-dependent correction *e*



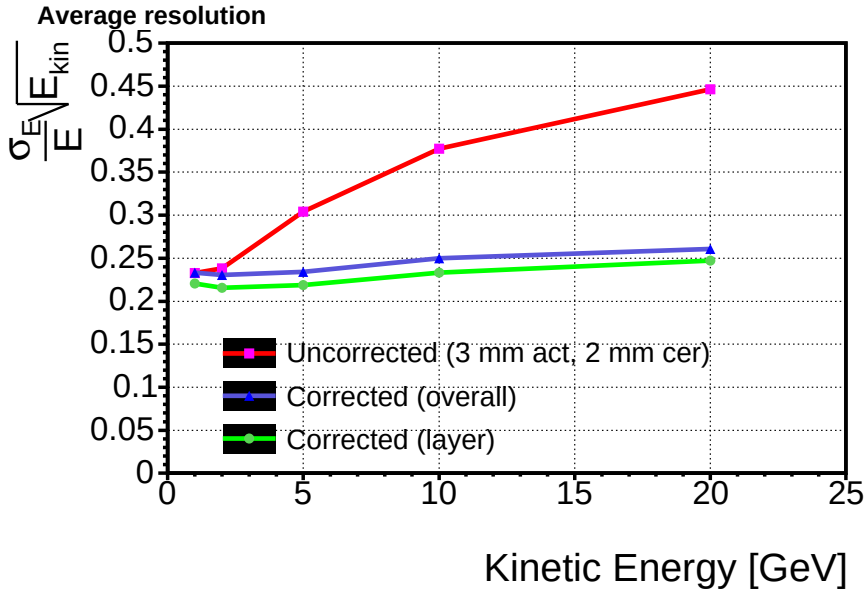
Corrected response of electrons

Response and Resolution

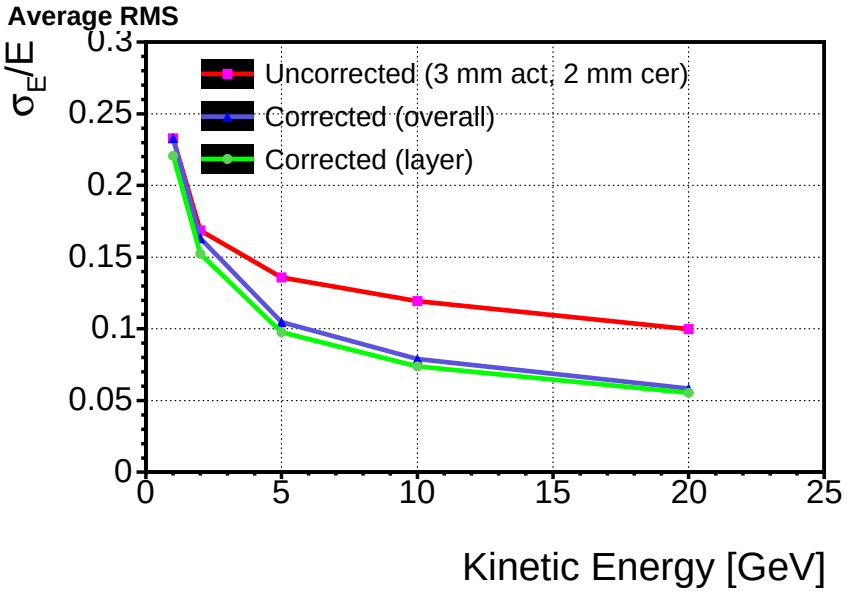
Response



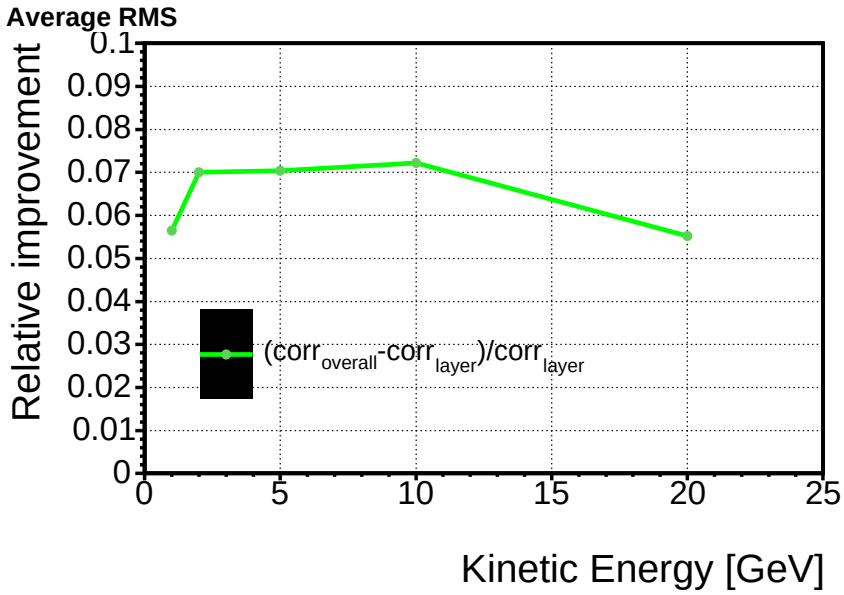
Resolution



σ_E/E



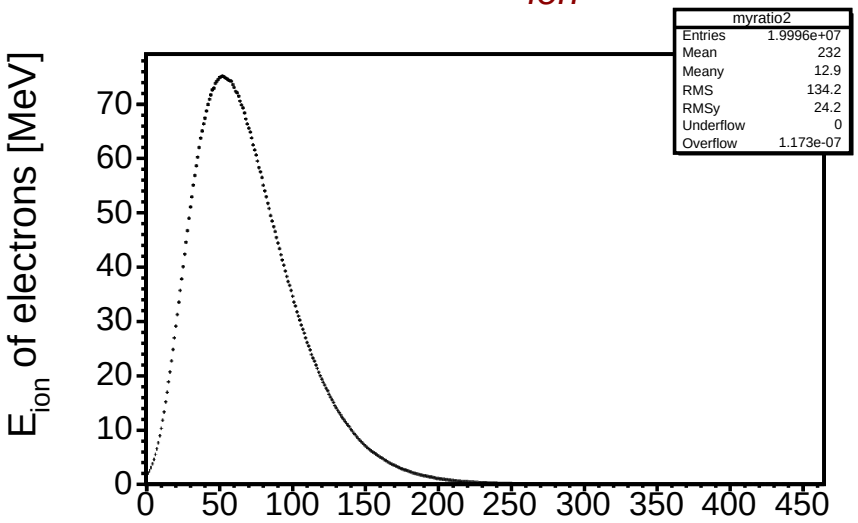
Relative improvement



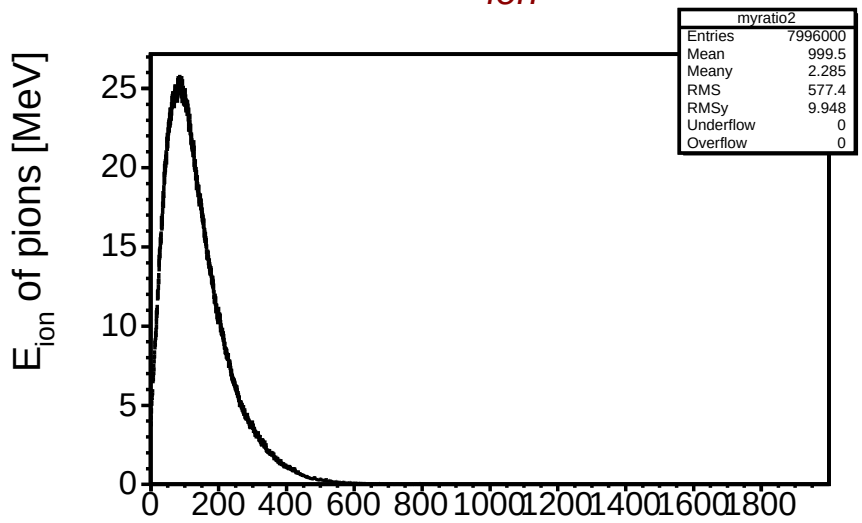
New

E_{ion} and f_{em} vs. Layer

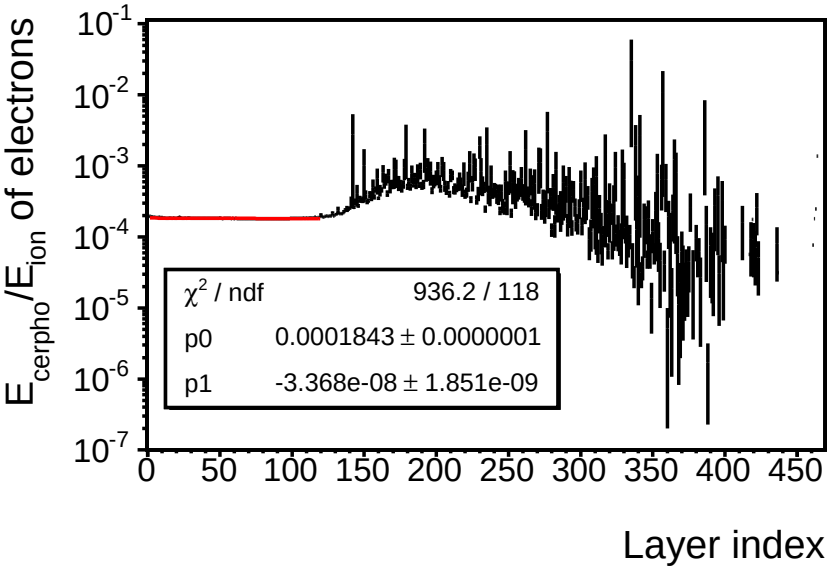
Electron E_{ion}



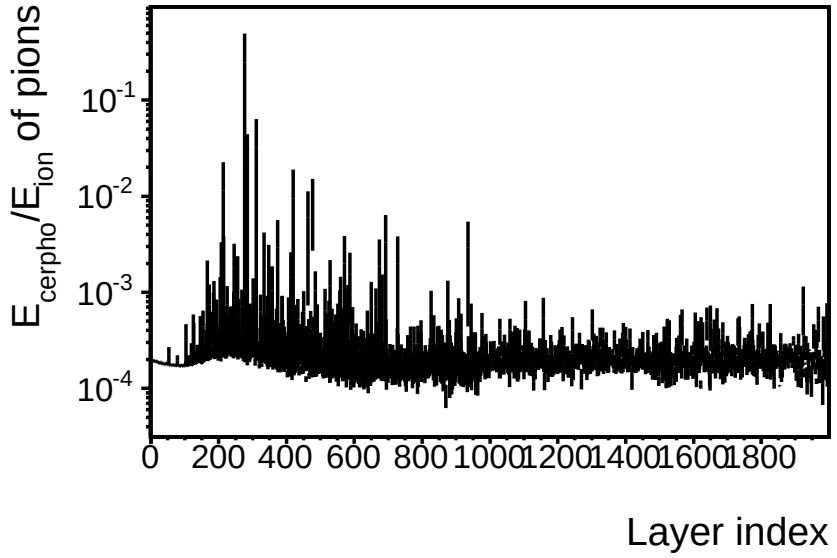
Pion E_{ion}



Electrons f_{em}



Pions f_{em}



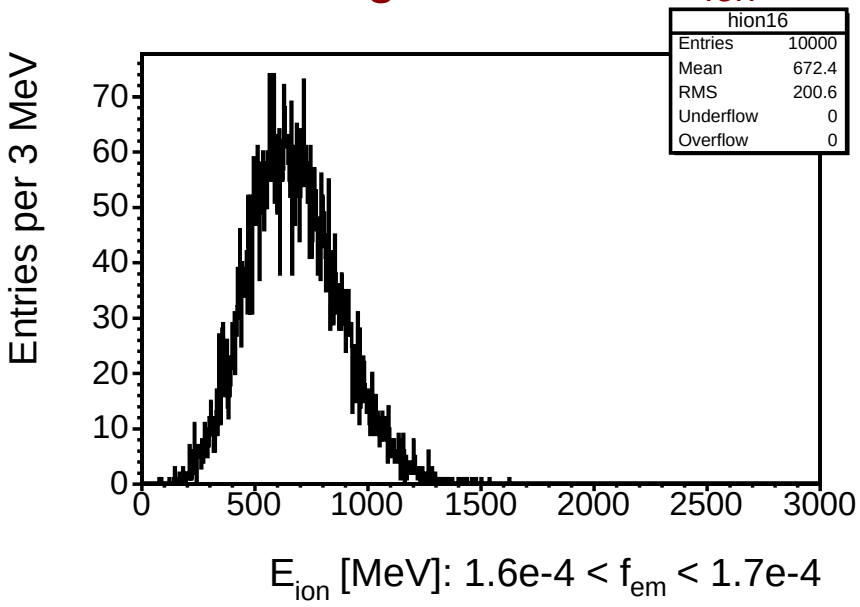
New

- We should apply the same f_{em} corrections to electron energy
- Can electrons introduce extra constraints?
- Try
  - Combine electron and pion sample and fit for $\beta(f_{em})$ together
  - Have tried two Gaussians with different widths when fitting the combined sample of electrons and pions
  - → give the same result if only fitting one particle type
  - → fit converges but give worse response and resolution (30%) when combining electrons and pions. Discarded.
  - Re-bin f_{em} so that f_{em} with similar value to that of electron is grouped to one bin
  - For this bin, fix $\beta(f_{em})$ to 1.66667

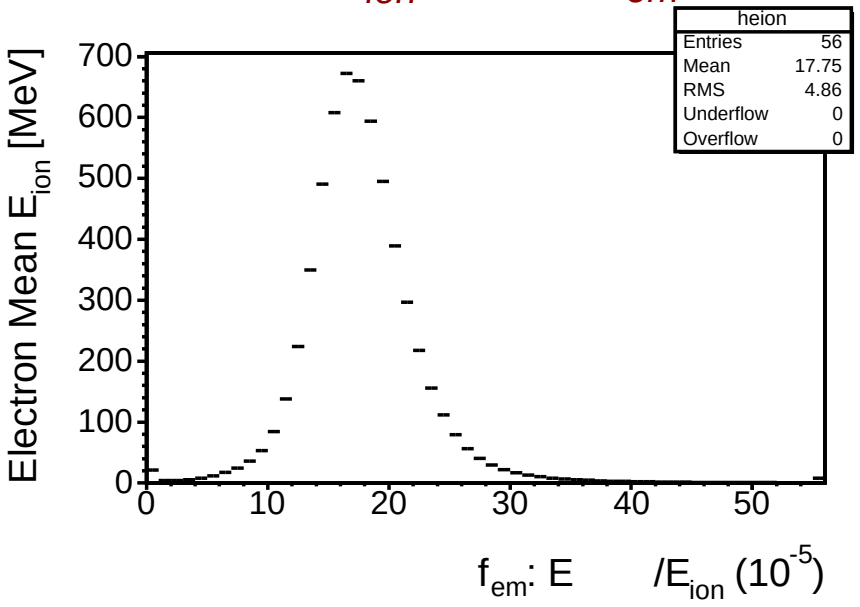
How to Re-bin f_{em}

- Check the mean electron ionization energy in bins of f_{em}
- Group the central 10 bins together
  - For both electrons and pions, do not fit for correction, apply for only sampling fraction correction 1.66667
- The rest of the bins are combined in bins of 2e-5. For $f_{em} > 5.6e\text{-}4$, consider as overflows.

Bins with highest mean E_{ion}

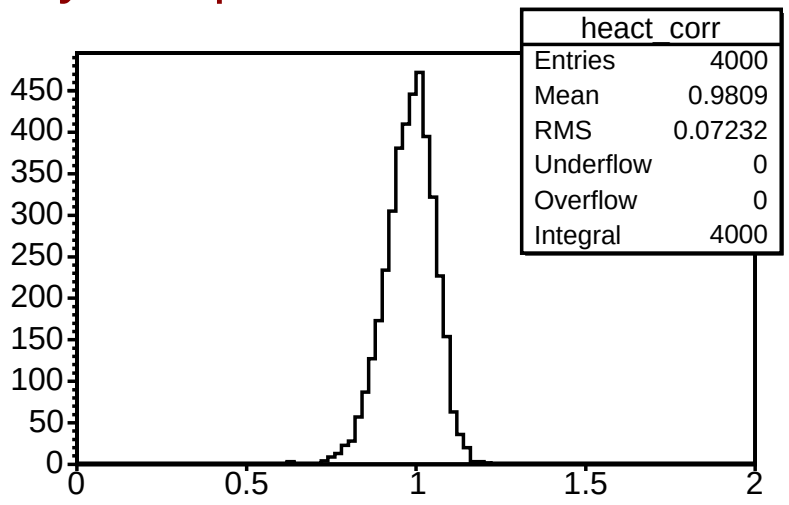


Mean E_{ion} versus f_{em}

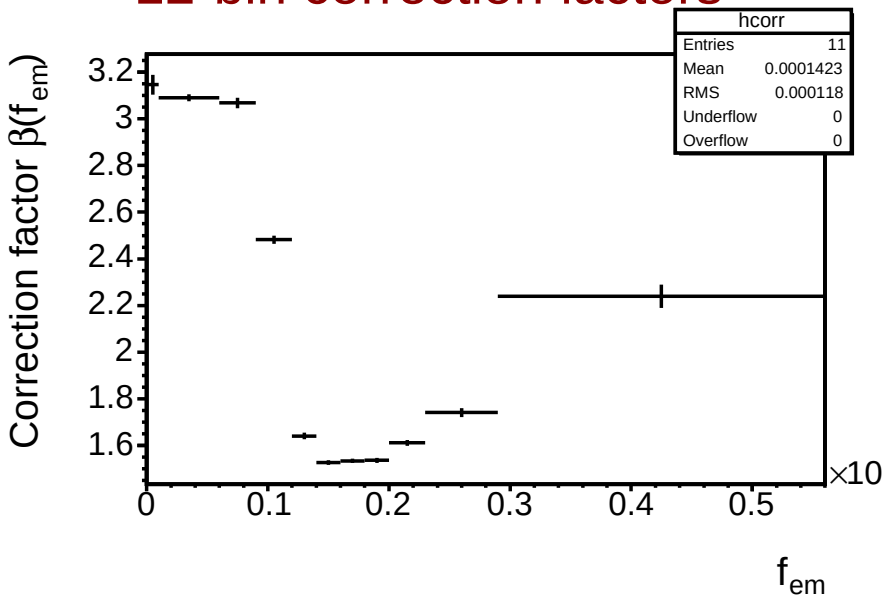


Results of Combining e, π (12bins)

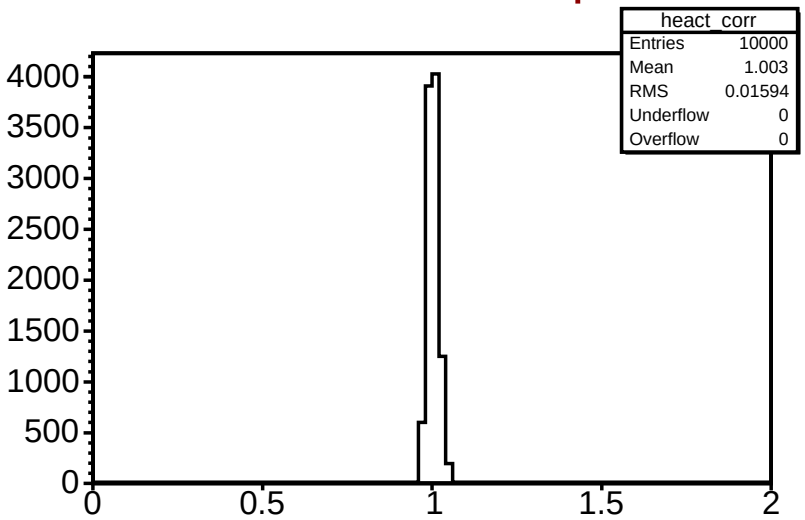
Layer-dependent correction π



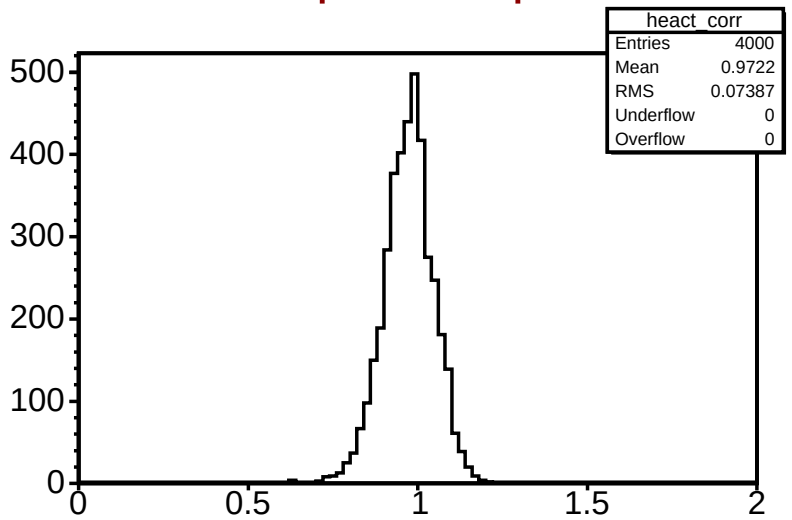
12-bin correction factors



Corrected electron response

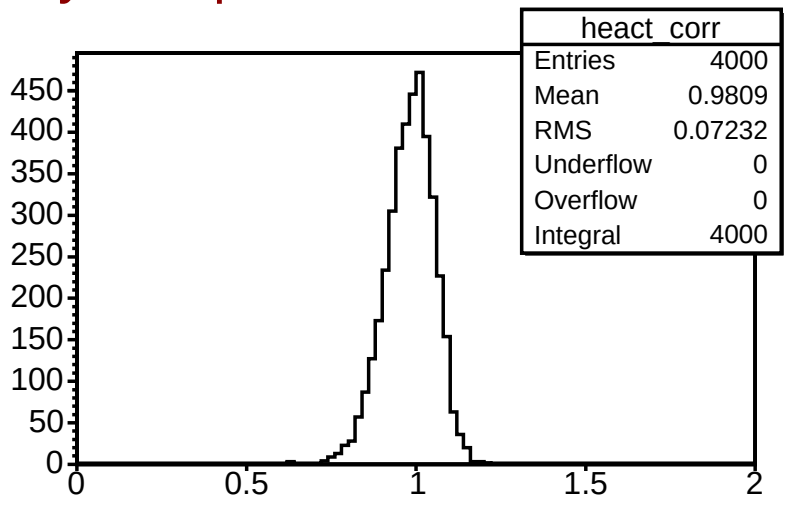


Corrected pion response



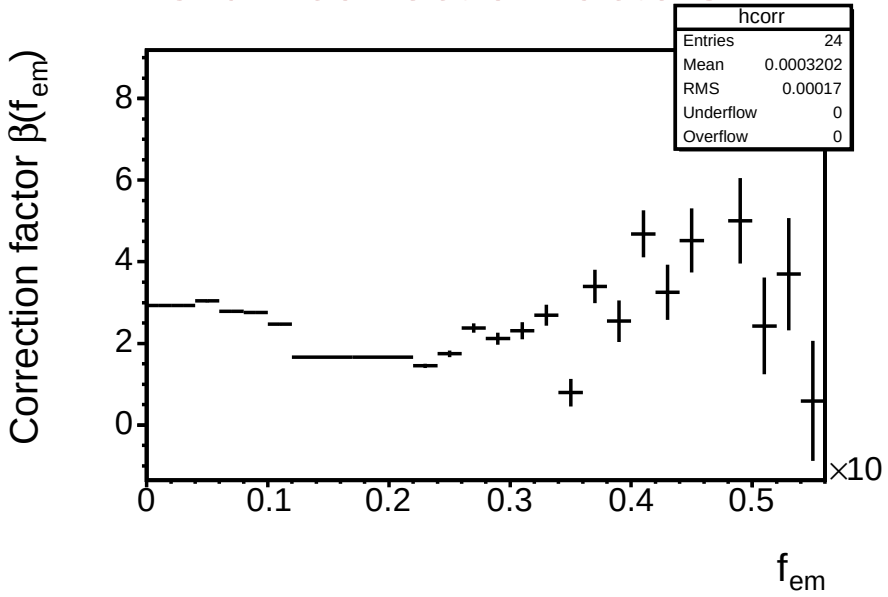
Results of Re-binning (25bins)

Layer-dependent correction π

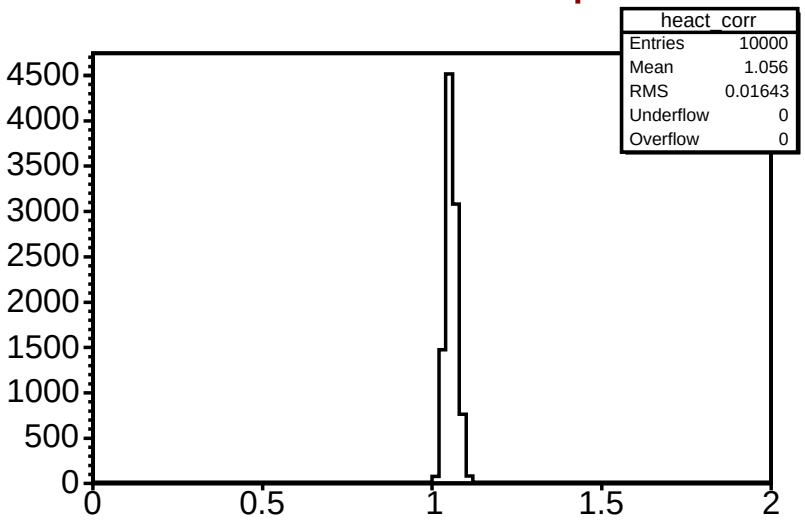


Corrected response of pions

25-bin correction factors

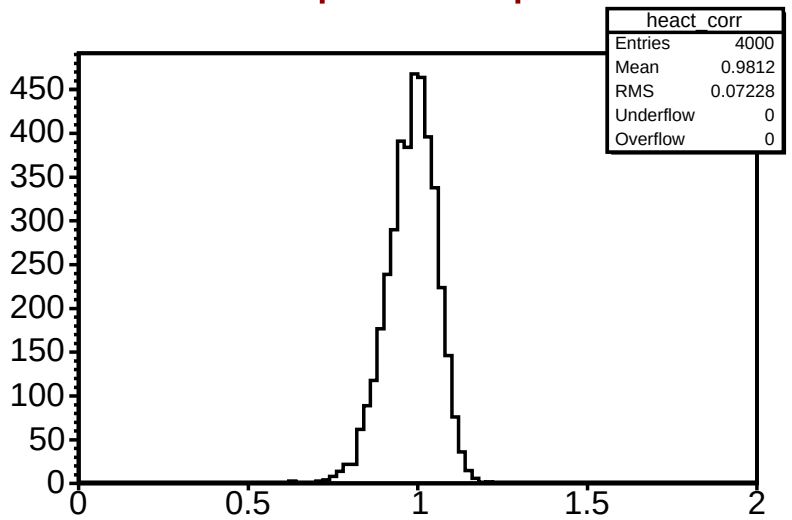


Corrected electron response



Corrected response of electrons

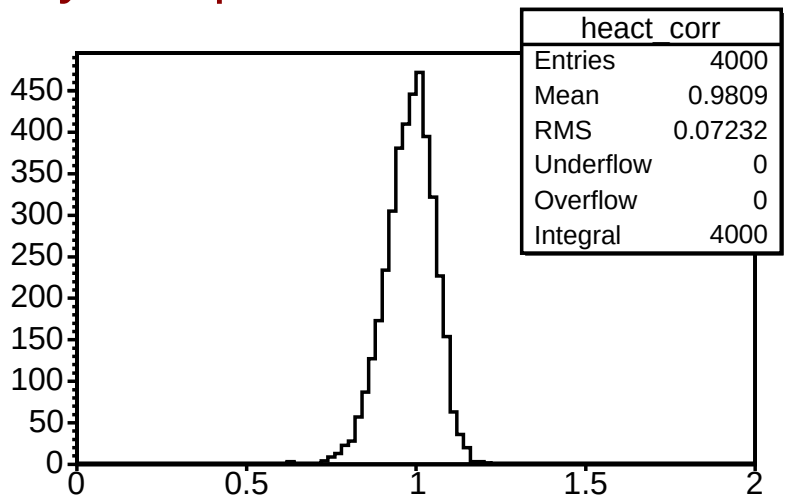
Corrected pion response



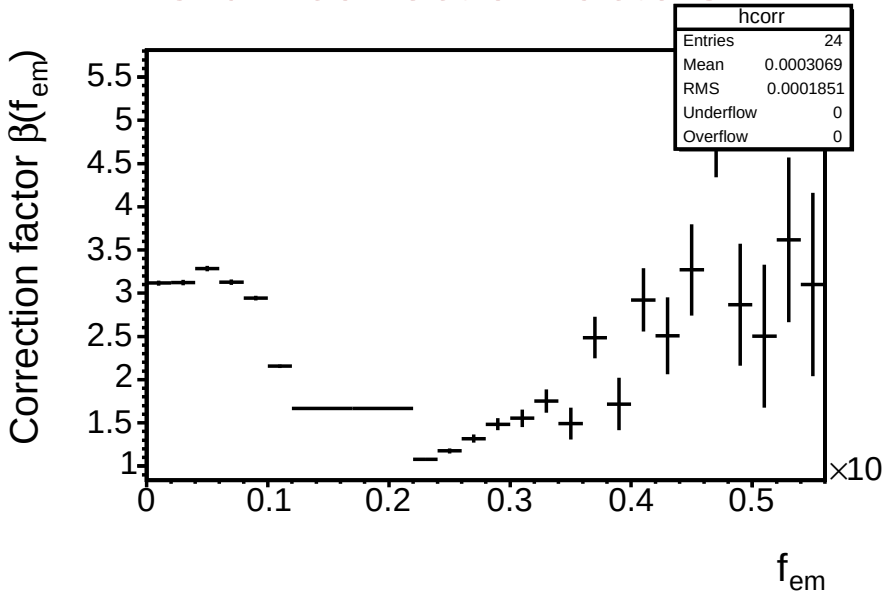
Corrected response of pions

Results of Re-binning and Combining e,π

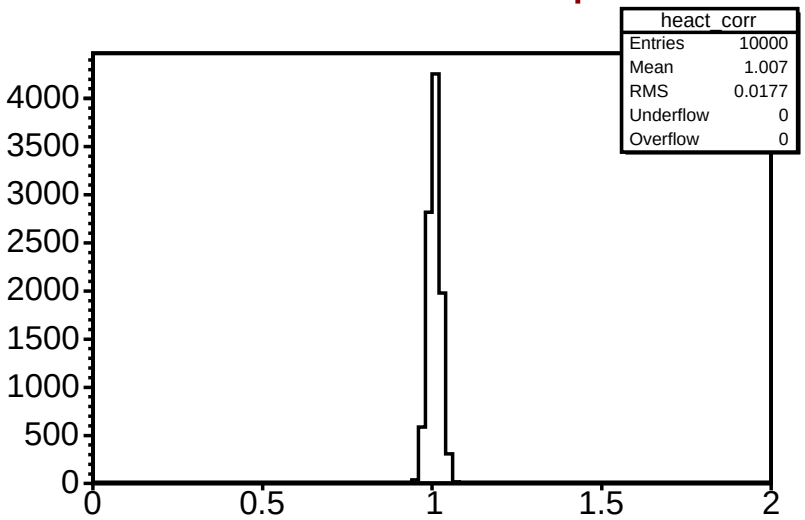
Layer-dependent correction π



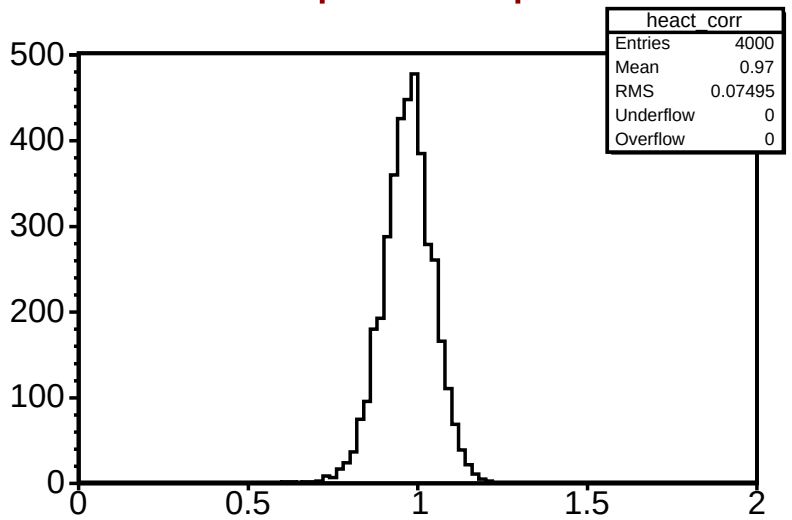
25-bin correction factors



Corrected electron response



Corrected pion response



Conclusion and Plans

- additional 0.5% improvement by rebinning and fixing correction factor to 1.66667 for layers with f_{em} between 1.2e-4 and 2.2e-4

→ but electron energy is over corrected by 5%!

- Need to compromise between over-correcting electron energy and better pion energy resolution
- Have tried also only grouping the central 5 f_{em} bins. Conclusions unchanged.
- Any more suggestions?
- Wait for longitudinal segmentation?